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L2: Entry 1 of 17 File: USPT Dec 11, 2001

US-PAT-NO: 6328803
DOCUMENT-IDENTIFIER: US 6328803 B1

TITLE: Method and apparatus for controlling rate of pressure change in a vacuum process chamber

DATE-ISSUED: December 11, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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US-CL-CURRENT: 118/715; 118/50, 118/663

CLAIMS:

What is claimed is:
1. A method for controlling a vacuum process for semiconductor wafers comprising:
providing a plurality of vacuum process chambers configured to perform the vacuum process, the chambers comprising pressure sensors configured to detect vacuum pressures in the chambers, valves in flow communication with the chambers configured to adjust the vacuum pressures, and controllers in signal communication with the pressure sensors configured to control the valves;
determining defects on selected wafers processed in the chambers using the vacuum process;
determining an optimal rate of pressure change in the chambers for reducing the defects during the vacuum process;
placing the wafers in the chambers and performing the vacuum process;
sensing the vacuum pressures in the chambers during the vacuum process using the pressure sensors; and
controlling the vacuum pressures to reduce the defects by maintaining the optimal rate of pressure change in the chambers during a pump down cycle and a vent up cycle of the vacuum process using the valves and the controllers.
2. The method of claim 1 wherein the chambers are located at different areas of a semiconductor manufacturing plant.
3. The method of claim 1 wherein the vacuum process comprises a vacuum deposition process or a vacuum etching process.
4. A method for controlling a vacuum process for a semiconductor wafer comprising:

providing a vacuum process chamber configured to perform the vacuum process;
determining an optimal rate of pressure change for reducing defects on the wafer during the vacuum process by detecting defects on a plurality of semiconductor wafers processed in different vacuum process chambers using the vacuum process;
expressing the optimal rate as a mathematical formula;
providing a valve in flow communication with the chamber;
providing a controller in signal communication with the valve and programmed with the mathematical formula;
placing the wafer in the chamber and performing the vacuum process; and
controlling a flow through the valve to the chamber during the vacuum process by sensing a pressure in the chamber, transmitting the pressure to the controller, and adjusting a position of the valve responsive to the controller to achieve the optimal rate of pressure change during a pump down cycle and a vent up cycle of the vacuum process.
5. The method of claim 4 wherein the pump down cycle is performed using a vacuum

pump and the vent up cycle is performed using an inert gas.
6. The method of claim 5 wherein the vacuum process comprises a vacuum etching process or a vacuum deposition process.
7. A method for controlling a vacuum process for a semiconductor wafer comprising:

providing a vacuum process chamber configured to perform the vacuum process;
providing a pressure sensor in the chamber configured to sense a pressure in the chamber;
providing a pump down valve in flow communication with the chamber and with a vacuum pump, and a vent up valve in flow communication with the chamber and with a supply of an inert gas;
providing a programmable controller in signal communication with the pressure sensor configured to adjust a flow rate through the pump down valve and the vent up valve responsive to signals from the pressure sensor;
determining an optimal rate of pressure change in the chamber for reducing defects on the wafer during the vacuum process by processing a plurality of semiconductor wafers using the vacuum process in a plurality of different process chambers with different rates of pressure change, then measuring the defects and then expressing the optimal rate as a mathematical formula;
programming the controller with the formula;
placing the wafer in the chamber and performing the vacuum process;
sensing a pressure in the chamber during the vacuum process and communicating the pressure to the controller; and
controlling the flow rate through the pump down valve and the vent up valve such that the rate of pressure change in the chamber during the vacuum process matches the optimal rate programmed into the controller.
8. The method of claim 7 wherein the vacuum process comprises a vacuum etching process.
9. The method of claim 7 wherein the vacuum process comprises a vacuum deposition process.
10. A method for controlling a vacuum process for semiconductor wafers comprising:

providing a plurality of vacuum process chambers;
providing a plurality of valves in flow communication with the chambers;
providing at least one controller for the valves configured to control flow rates through the valves;
providing a plurality of pressure sensors in the chambers in electrical communication with the controller configured to sense pressures in the chambers;
determining an optimal rate of pressure change in the chambers for reducing defects on the wafers during the vacuum process by processing a plurality of semiconductor wafers using the vacuum process in a plurality of different process chambers with different rates of pressure change and then measuring the defects;
placing the wafers in the chambers and performing the vacuum process; and
matching rates of pressure change in the chambers to the optimal rate during a pump down cycle and a vent up cycle of the vacuum process by controlling the flow rates through the valves using the controller and the pressure sensors.
11. The method of claim 10 further comprising providing the controller with a mathematical formula representative of the optimal rate.
12. The method of claim 10 wherein the vacuum process comprises a vacuum etching process or a vacuum deposition process.
13. A vacuum system for semiconductor wafers comprising:
a first process chamber and a second process chamber configured to perform a vacuum process on the wafers but located at different areas of a semiconductor manufacturing plant;
a first pressure sensor in the first process chamber and a second pressure sensor in the second process chamber; and
a controller coupled to the first pressure sensor and to the second pressure sensor configured to control flow rates from the first chamber and the second chamber such that a rate of pressure change in the first chamber and the second chamber during a pump down cycle and during a vent up cycle of the vacuum process matches an optimal rate of pressure change selected to reduce defects in the wafers.
14. The system of claim 13 further comprising a first vacuum pump in flow communication with the first process chamber and a second vacuum pump in flow communication with the second process chamber.
15. A vacuum system for semiconductor wafers comprising:
a frame;
a first process chamber on the frame and a second process chamber on the frame configured to perform a vacuum process on a plurality of semiconductor wafers;

a first pressure sensor in the first process chamber and a second pressure sensor in the second process chamber;
a first control valve in flow communication with the first process chamber and a second control valve in flow communication with the second process chamber; and
a controller coupled to the first control valve and to the first pressure sensor, and coupled to the second control valve and to the second pressure sensor, the controller responsive to the first pressure sensor and to the second pressure sensor to match a rate of pressure change in the first chamber and in the second chamber during a pump down cycle and a vent up cycle of the vacuum process to an optimal rate of pressure change selected to reduce defects in the wafers during the vacuum process.
16. The system of claim 15 wherein the controller is programmed with a mathematical formula representing the optimal rate of pressure change.
17. The system of claim 15 further comprising a first vacuum pump in flow communication with the first vacuum chamber and a second vacuum pump in flow communication with the second vacuum chamber.
18. The system of claim 15 wherein the vacuum process comprises a vacuum deposition process or a vacuum etching process.
19. A vacuum system for semiconductor wafers comprising:
a first process chamber and a second process chamber configured to perform a vacuum process on the wafers;
a first pressure sensor for sensing a first pressure in the first process chamber and a second pressure sensor for sensing a second pressure in the second process chamber;
a first control valve for controlling a first flow rate to or from the first process chamber and a second control valve for controlling a second flow rate to or from the second process chamber;
at least one controller responsive to the first pressure sensor for controlling the first control valve and responsive to the second pressure sensor for controlling the second control valve, the controller programmed with an optimal rate of pressure change which is empirically determined by measuring defects on a plurality of different wafers processed with the vacuum process in a plurality of different process chambers, the optimal rate selected to reduce the defects in the wafers during the vacuum process, the controller configured to adjust the first control valve responsive to the first pressure sensor and to adjust the second control valve responsive to the second pressure sensor to achieve the optimal rate in the first process chamber and in the second process chamber.
20. The vacuum system of claim 19 wherein the first process chamber and the second process chamber are on a same frame.
21. The vacuum system of claim 19 wherein the first process chamber and the second process chamber are on separate pieces of equipment.
22. The vacuum system of claim 19 wherein the vacuum process comprises a vacuum deposition process.
23. The vacuum system of claim 19 wherein the vacuum process comprises a vacuum etching process.

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L2: Entry 5 of 17 File: USPT Sep 19, 2000

US-PAT-NO: 6120606
DOCUMENT-IDENTIFIER: US 6120606 A

TITLE: Gas vent system for a vacuum chamber

DATE-ISSUED: September 19, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Peng; Ming-Tang	Hsinchu			TWX

US-CL-CURRENT: 118/719; 118/50, 118/733, 137/110, 137/111, 137/587, 137/624.11, 414/935, 414/939, 417/306, 454/238, 454/255

CLAIMS:

What is claimed is:
1. A gas vent system for vacuum chamber, said system comprising:
a gas supply;
an anti-vibrating tube connected after said gas supply for transferring gas without introducing vibration from said gas supply to said vacuum chamber;
a gas regulator connected after said anti-vibrating tube for controlling a flow rate of said gas;
a first line with a first metering valve connected after said gas regulator, said first lines allowing said gas to pass through into said vacuum chamber in a first flow rate for minimizing generated particles due to a pressure difference when venting said gas into said vacuum chamber;
a second line connected after said gas regulator, said second line being connected in parallel with said first line, said second line having a second metering valve and an in-line valve in series, after said first line starts to vent said gas into said vacuum chamber, said second line allowing said gas to pass through into said vacuum chamber in a second flow rate higher than said first flow rate for increasing a venting rate of said vacuum chamber by opening said first line and said second line at a same time;
a vent valve connected after said first line and said second line but before the vacuum chamber; and
a filter connected between said vent valve and said vacuum chamber.
2. The system of claim 1 further comprising a pressure sensor for detecting a pressure of said vacuum chamber.
3. The system of claim 1, wherein said chamber is a wafer transfer chamber for a scanning electron microscope system.
4. The system of claim 1, wherein said gas comprises nitrogen.
5. The system of claim 1, wherein said gas supply comprises a facility gas valve box.
6. The system of claim 1, wherein said anti-vibrating tube comprises a flexible metal tube.
7. The system of claim 1, wherein said anti-vibrating tube comprises a bellow-type tube.
8. The system of claim 1, wherein said in-line valve comprises a first air-operated valve.
9. The system of claim 1, wherein said vent valve comprises a second air-operated valve.
10. The system of claim 1, wherein said gas supply, said anti-vibrating tube, said gas regulator, said first metering valve, said second metering valve, said in-line valve, said vent valve, and said filter are connected by sealings with metal gaskets.

11. The system of claim 1 further comprising a time delaying device for controlling a valve opening time delay between said vent valve and said in-line valve.

12. A gas vent system for a vacuum chamber, said chamber being a wafer transfer chamber for a scanning electron microscope device, said system comprising:

a gas supply for supplying nitrogen;

an anti-vibrating tube connected after said gas supply for transferring gas without introducing vibration from said gas supply to said vacuum chamber;

a gas regulator connected after said anti-vibrating tube for controlling a flow rate of said gas;

a first line with a first metering valve connected after said gas regulator, said first line allowing said gas to pass through into said vacuum chamber in a first flow rate for minimizing generated particles due to a pressure difference when venting said gas into said vacuum chamber;

a second line connected after said gas regulator, said second line being connected in parallel with said first line, said second line having a second metering valve and an in-line valve in series, after said first line starts to vent said gas into said vacuum chamber, said second line allowing said gas to pass through into said vacuum chamber in a second flow rate higher than said first flow rate for increasing a venting rate of said vacuum chamber by opening said first line and said second line at a same time;

a vent valve connected after said first line and said second line but before said vacuum chamber;

a time delaying device for controlling a valve opening time delay between said vent valve and said in-line valve, thereby lagging said second line to open behind said first line;

a filter connected between said vent valve and said vacuum chamber; and

a pressure sensor for detecting a pressure of said vacuum chamber.

13. The system of claim 12, wherein said anti-vibrating tube comprises a flexible metal tube.

14. The system of claim 12, wherein said in-line valve comprises a first air-operated valve.

15. The system of claim 12, wherein said vent valve comprises a second air-operated valve.

16. The system of claim 12, wherein said gas supply, said anti-vibrating tube, said gas regulator, said first metering valve, said second metering valve, said in-line valve, said vent valve, and said filter are connected by sealings with metal gaskets.

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L2: Entry 3 of 17 File: USPT Apr 17, 2001

US-PAT-NO: 6217657
DOCUMENT-IDENTIFIER: US 6217657 B1

TITLE: Resist processing system having process solution deaeration mechanism

DATE-ISSUED: April 17, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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Semba; Norio	Kumamoto			JPX
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US-CL-CURRENT: 118/692; 118/319, 118/320, 118/52, 118/56, 118/600, 118/610, 118/693, 118/694, 118/712

CLAIMS:

What is claimed is:
1. A resist processing system comprising:
a mounting table for mounting a substrate thereon;
a nozzle for expelling out a processing solution to the substrate mounted on the mounting table;
a vessel for storing the processing solution;
pressurizing means for introducing a pressurized gas into the vessel, thereby pressurizing the processing solution to send the processing solution from the vessel to the nozzle;
a processing solution supply line provided between the vessel and the nozzle, for guiding the processing solution sent out from the vessel by said pressurizing means, to the nozzle; and
a deaeration mechanism attached to said processing solution supply line, for separating and removing a gaseous component from the processing solution;
said deaeration mechanism comprising
an airtight chamber,
a gas-liquid separation membrane provided in the airtight chamber, one side portion of which is communicated with said processing solution supply line through which said processing solution is supplied to said one side portion,
a vacuum evacuation line communicated with the other side portion of the gas-liquid separation membrane,
evacuation means for evacuating the other side portion of the gas-liquid separation membrane through the vacuum evacuation line, and
a trap tank attached to the vacuum evacuation line, for receiving a liquid component permeating through the gas-liquid separation membrane and leaking into the vacuum evacuation line.
2. A system according to claim 1, wherein said evacuation means comprises
an ejector main body communicated with the vacuum evacuation line,
another line communicated with the ejector main body, and
fluid supply means for sending a fluid to said another line, thereby reducing pressure of the vacuum evacuation line.
3. The system according to claim 1, wherein said evacuation means is a vacuum pump which is communicated directly with the vacuum evacuation line, for reducing pressure in the vacuum evacuation line.
4. The system according to claim 1, further comprising an intermediate tank attached to the processing solution supply line between said vessel and the deaeration mechanism, for temporarily storing the processing solution before the

solution is supplied to the deaeration mechanism.
5. The system according to claim 1, wherein
said vacuum evacuation line has a stop valve, a first solenoid valve, an ejector, a regulator, a gauge, and a second solenoid valve.
6. The system according to claim 1, wherein
said processing solution supply line is branched, each branched line being communicated with the nozzle.
7. The system according to claim 1, wherein
said gas-liquid separation membrane is constituted of a plurality of capillaries made of any one of a porous film, a non-porous film, and a composite film.
8. The system according to claim 7, wherein said porous film is a porous thin film made of polytetrafluoroethylene(PTFE) or a polyolefin-series resin; said non-porous film is a non-porous thin film made of a tetrafluoroethylene.hexafluoropropylene copolymer (FEP), a tetrafluoroethylene.perfluoroalkylvinyl ether copolymer (PFA), or polytetrafluoroethylene (PTFE); and said composite film is a composite film made by combining the porous film and the non-porous film.
9. The system according to claim 4, further comprising:
a controller for controlling the pressurizing means and the evacuation means;
a first sensor connected to an input terminal of the controller, for detecting a surface level of the processing solution contained in the intermediate tank;
a second sensor connected to the input terminal of the controller, for detecting a surface level of the liquid component contained in the trap tank; and
a third sensor connected to the input terminal of the controller, for detecting an inner pressure of the trap tank;
wherein said controller controls the pressurizing means on the basis of a detection signal output from the first sensor and further controls the evaluation means on the basis of detection signals output from the second and third sensors.
10. The system according to claim 9, further comprising:
a display portion connected to an output terminal of the controller, for displaying data obtained from at least one of the detection signals output from the first, second and third sensors; and
an alarm portion connected to the output terminal of the controller, for giving an alarm when one of the detection signals of the first, second and third sensors indicates an abnormal condition.